



the **ENERGY** lab

PROJECT FACTS

Carbon Storage - GSRA

Geological and Geotechnical Site Investigations for the Design of a CO₂ Rich Flue Gas Direct Injection and Storage Facility in an Underground Mine in the Keweenaw Basalts

Background

Fundamental and applied research on carbon capture, utilization and storage (CCUS) technologies is necessary in preparation for future commercial deployment. These technologies offer great potential for mitigating carbon dioxide (CO₂) emissions into the atmosphere without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCUS technical and non-technical disciplines that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCUS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL), through funding provided by the American Recovery and Reinvestment Act (ARRA) of 2009, manages 43 projects that received more than \$12.7 million in funding. The focus of these projects has been to conduct geologic storage training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO₂ storage; and CO₂ capture.

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PARTNERS

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U.S. DEPARTMENT OF
ENERGY

PROJECT DURATION

Start Date

12/01/2009

End Date

03/25/2013

COST

Total Project Value

\$299,762

DOE/Non-DOE Share

\$299,762 / \$0



Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

Project Description

DOE has partnered with the University of Alaska Fairbanks to conduct research and training to develop a methodology for the geologic and geotechnical site characterization of mafic rocks through field work and simulation. Mafic rocks are dark igneous rocks with a high magnesium and ferrous iron content. Basalt is the most common mafic rock (Figure 1). Basalt formations have a unique chemical makeup that could potentially convert all of the injected CO₂ to a solid mineral form, permanently isolating it from the atmosphere. The methodology in this project is attempting to define the parameters that enhance rock carbonation and permanent storage by directly injecting CO₂ enriched flue gas streams into large underground cavities in basaltic and gabbroic rocks. A small demonstration project will be conducted in which 100 tons of CO₂ will be injected. Project site selection will be determined following a thorough characterization effort of two candidate mine sites.



Figure 1. Keweenaw Basalt, Chippewa Falls, near Batchawana Bay, Ontario

Mine tailings (the materials left over after coal and mineral ore extraction) is being examined, sampled, and tested throughout the 100 mile long by three mile wide Keweenaw Copper Belt in the upper peninsula of Michigan to estimate the extent of carbonation as a consequence of exposure to atmospheric CO₂ resulting from 100 plus years of mine operations. The focus of this effort is on characterizing secondary carbonate minerals that have precipitated on the mine tailings following exposure to atmospheric CO₂. These samples are being used as comparative analogs to assess the physical and chemical property changes

expected following CO₂ injection into mafic rock within the region. Based on these characterizations, a volume of naturally stored atmospheric CO₂ will be estimated to provide a minimum estimate of the potential for carbonation of the basalts at the higher temperature, pressure, and chemical partitioning of CO₂ from flue gas streams. Instrumentation techniques will be developed based on the results of the mine and tailings site characterization work, to monitor injection direction and determine the CO₂ storage capacity of the basalts. Finally, design and cost estimates will be developed for a direct injection and storage demonstration project at the selected mine site.

Goals/Objectives

The primary objective of the DOE's Carbon Storage Program is to develop technologies to safely and permanently store CO₂ and reduce Greenhouse Gas (GHG) emissions without adversely affecting energy use or hindering economic growth. The Programmatic goals of Carbon Storage research are: (1) estimating CO₂ storage capacity in geologic formations; (2) demonstrating that 99 percent of injected CO₂ remains in the injection zone(s); (3) improving efficiency of storage operations; and (4) developing Best Practices Manuals (BPMs). The specific objective of this project is to provide an opportunity for graduate and undergraduate students to participate in research to develop a methodology for the geologic and geotechnical site characterization of mafic rocks via simulations, field work, and analysis of existing data. Research will ultimately be used to compile an economic analysis for using mafic rocks as a CO₂ storage option. These efforts support the Carbon Storage Program goals for ensuring CO₂ storage permanence and enhancing storage capacity estimates.

Accomplishments

- As of March 2012, two students had accumulated 2,346 training-related hours under the program.
- Collected 250 samples from 30 mine tailings sites in the Keweenaw Copper Belt. Continued sample processing for mineralogical, petrological, and chemical characterization of the rocks to estimate the extent of carbonation of mine waste as a consequence of atmospheric CO₂ over the 100 plus years of mine operations
- Initiated work at the Caledonia Mine, Mass City, Michigan for the determination of the presence of secondary hydrous carbonate minerals.

Benefits

Overall the project is making a vital contribution to the scientific, technical, and institutional knowledge necessary to establish frameworks for the development of commercial-scale CCUS and will provide insight to further the understanding of CCUS in mafic rocks. By characterizing mafic rocks, estimating the potential for carbonation and overall storage within basalts, and estimating costs associated with such an effort, the research is commensurate with the NETL Carbon Storage Division goals of ensuring storage permanence of CO₂ within the injection zone and estimating storage capacity within geologic formations. This research is also producing providing training that will produce experts in predicting the storage capacity and potential movement of stored CO₂ in mafic rocks.

